



IMPROVED EDGEWISE ORTHODONTIC BRACKET

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Dea
08/060879

RELATED APPLICATIONS

This application is a continuation-in-part of
5 International Application No. PCT/US92/04263, filed May 20,
1992, which claims priority from U.S. Patent No. 5,160,261,
issued November 3, 1992.

FIELD OF THE INVENTION

10 This invention generally relates to edgewise
orthodontic brackets and, more particularly, to edgewise
brackets having enhanced treatment, comfort and ease-of-use
features, as well as increased modalities.

15 BACKGROUND OF THE INVENTION

Orthodontic brackets are widely used to align teeth
through the application of forces selectively provided by
interconnected archwires and accessories. Brackets are
typically of metal, ceramic or composite construction and
20 are interconnected to either bands or bonding pads for
attachment to teeth.

In edgewise brackets, an archwire passes through a
labially opening, horizontal slot defined by one or more
pair of opposing tie wings. The archwire is preshaped and
25 sized to provide the desired forces. In each bracket, a
tie wing pair includes a gingivally extending tie wing and
occlusally extending tie wing. Once placed in the slot of
one or more pair of tie wings, an archwire is typically

restricted therein by a ligating device such as a steel or elastomeric ligature.

As orthodontic treatment objectives and techniques continue to evolve, numerous corresponding edgewise bracket designs and interconnecting accessories have been proposed. Recently, it has been recognized that it is desirable to reduce frictional engagement between the archwire and bracket surfaces defining the archwire slot to facilitate space closure and bodily tooth movement. Similarly, in many situations, it is now a goal to reduce frictional engagement between the archwire and ligating device employed to restrict the archwire within the slot. Such friction reduction can markedly increase the rate of tooth movement and reduce the duration of the orthodontic treatment.

At the same time, patient comfort and ease-of-use considerations have become increasingly important. Patient comfort has been largely addressed by reducing bracket size to yield smaller and more smoothly contoured brackets. Ease-of-use considerations have stimulated bracket designs which facilitate practitioner's bracket placement/use and accommodate plural modalities.

The present invention represents significant advances in relation to the above-noted orthodontic bracket considerations, both singularly and combinatively, while maintaining the structural integrity of the bracket.

SUMMARY OF THE INVENTION

In one aspect of the present invention, an edgewise bracket is provided having a pair of tie wings defining an archwire slot therebetween, and a pair of ligating support means, one defined within the mesial/distal extent of each tie wing. The ligating support means may be selectively employed to reduce frictional engagement between an archwire positioned in the slot and a ligating device positioned on the ligating support means and across the archwire slot. Each ligating support means includes a sloped, or angled, portion that extends labially toward the slot (e.g., labially from the gingival/occlusal periphery towards the slot), to reduce binding of a ligating device positioned thereupon. The ligating support means are preferably notches extending from the gingival or occlusal periphery of a tie wing, sized to readily receive a ligating device, and preferably having a curvilinear, concave configuration to further reduce binding. Typically, the opposing notches in a given pair of tie wings will have a common center axis which is parallel to the gingival-occlusal center axis of the bracket. When the archwire slot includes convex sidewall and/or floor portions to reduce archwire/bracket frictional engagement, the ligating support means are preferably disposed adjacent thereto (e.g., centered upon a common gingival-occlusal plane) for enhanced treatment control.

In another aspect of the present invention, an edgewise bracket is provided having a single pair of tie

wings and two pairs of opposing ligating support means defined within the mesial/distal extent of the tie wings, one pair on each of the mesial and distal sides of the bracket. The gingival/occlusal extremes of the tie wings
5 define an elliptical configuration when viewed from the labial ("viewed labially"). More particularly, each tie wing comprises central, mesial and distal portions which extend gingivally or occlusally, with ligating support means defined between the central and mesial portions and
10 between the central and distal portions, wherein the gingival/occlusal edges of such portions define an elliptical configuration. Such configuration accommodates size reduction, yielding patient comfort benefits, while preserving structural integrity and performance.

15 In this regard, and as will become apparent, a single pair of opposing T-shaped tie wings is preferred. That is, the "caps" of the T-shaped tie wings define an archwire slot therebetween, and the "center legs" of each tie wing extends gingivally or occlusally. The ligating support
20 means are preferably notches defined on the gingival/occlusal periphery on both the mesial and distal sides of a center leg of each T-shaped tie wing. The center legs each comprise a gingivally/occlusally extending cantilevered portion that can be conveniently employed as
25 a stanchion for ligature interconnection. The mesial/distal tie wing tip portions on the outside of each notch also comprise gingivally/occlusally extending cantilevered portions that extend a sufficient distance outward from the

outer tie wing sidewalls to retain a ligating device in an arcuate seat formed under the cantilevered tie wing tip portions and center legs during conventional ligation. Relatedly, the cantilevered center leg of each T-shaped tie wing should extend at least approximately the same distance outward beyond the outer gingival/occlusal extremes of the adjacent ligating support means so as to retain a ligating device when the ligating support notches are selectively employed by a practitioner to support a ligating device.

10 In a further aspect of the present invention, an edgewise bracket is provided having a single pair of tie wings defining an archwire slot therebetween, and an integral T-shaped hook extending gingivally/occlusally (typically only gingivally) from one tie wing, and in
15 perpendicular relation to the longitudinal center axis of the archwire slot, wherein traction devices (e.g., rubber bands, springs, etc.) can be readily attached from a plurality of directions so as to accommodate plural modalities for treatment. The T-shaped hook is centered
20 upon the gingival-occlusal center axis of the bracket, and is preferably provided as a cantilevered extension of the center leg of a T-shaped tie wing so as to communicate external force moments created by inter-connected traction devices close to a tooth's root center of resistance.
25 Preferably, the T-shaped hook is generally flat as viewed from the mesial and distal aspects. Further, as viewed from the labial aspect, the T-shaped hook preferably comprises a tapered portion contiguous to the center leg of

the T-shaped tie wing, an arcuate neck portion contiguous thereto, and a head portion contiguous thereto the tapered portion, wherein a traction device may be reliably maintained in the neck portion. That is, the tapered
5 portion serves to restrict movement of the traction device towards the archwire slot of the bracket, and the head portion serves to restrict disconnection of the traction device from the T-shaped hook. The integral T-shaped hook preferably comprises a malleable material so as to allow
10 for selective pivotal movement of the T-shaped hook by the orthodontic practitioner as may be desirable for soft tissue clearance and patent comfort.

In yet another aspect of the present invention, an edgewise bracket is provided having at least one pair of
15 tie wings defining an archwire slot therebetween, wherein when viewed from mesial/distal aspects, the gingivally/occlusally facing outer sidewalls of the tie wing pair define a trapezoid. One outer sidewall is disposed at an angle relative to the longitudinal center plane of the
20 archwire slot, wherein the sidewall extends labially away from such center plane. The other sidewall is disposed substantially parallel to the archwire slot center plane. The angled sidewall is typically disposed gingivally in both maxillary and mandibular applications. By way of
25 example, use of the described configuration and positioning allows for enhanced, early treatment of partially erupted upper bicuspsids, wherein the archwire slot will be acceptably, gingivally positioned upon full eruption of the

bicuspid. This enhances treatment and reduces demands upon the practitioner time. Further, bracket systems of this design will generally reduce bracket/tooth contact between the upper and lower arches. Bracket profile and strength can also be acceptably maintained using the described configuration. The benefits associated with this trapezoidal configuration may be extended to orthodontic treatment applications requiring positive, negative, or no torque by appropriately configuring/contouring the occlusal/gingival extent of the bracket base or bottom.

In another aspect of the present invention, an edgewise bracket is provided having one tie wing pair defining an archwire slot therebetween and at least one auxiliary slot extending from a gingival edge to the occlusal edge, or vice versa, wherein the slot and shaft of the auxiliary device to be inserted into the slot have complimentary configurations to restrict rotational movement therebetween. By way of example, the auxiliary slot may have adjoining flat inner sidewalls (e.g., defining square corners), and the auxiliary shaft may have complimentary flat outer sidewalls (e.g., defining square corners), wherein rotational movement therebetween is desirably restricted.

In a related aspect of the present invention, an edgewise bracket is provided having a single tie wing pair defining an archwire slot therebetween, at least one convex portion extending labially and transversely across the floor of the archwire slot, and at least one auxiliary slot

extending gingivally/occlusally and positioned under the convex slot floor portion. By positioning the auxiliary slot under the convex slot floor portion, bracket height can be advantageously conserved, and therefore reduced, so as to enhance patient comfort. When two convex slot floor portions are provided, one on each of the mesial/distal sides, twin auxiliary slots may be advantageously positioned so that one passes under each of the convex slot floor portions. In addition to the above-noted advantages, this bracket yields significant tooth rotation capabilities. For example, in early treatment stages, the twin auxiliary slots can be utilized with a steel ligature to achieve rapid gross tooth rotation. As can be appreciated, complementary auxiliary slot/auxiliary shaft configurations of the above-described nature can also be employed.

In one embodiment of the present invention, an edgewise bracket is provided having a single set of opposing T-shaped tie wings with ligating support notches defined on each side (i.e., mesially and distally) of the center leg of each tie wing. The sidewalls defining the archwire slot are provided to present two sets of opposing convex sidewall portions, one set on each of the mesial and distal sides of the bracket. Similarly, the floor of the archwire slot is provided to present two convex portions extending labially and transversely across the slot, one on each of the mesial and distal sides of the bracket. By virtue of this arrangement, the bracket yields desirable

tooth rotation and alignment capabilities with reduced archwire/archwire slot frictional engagement and selectively reduced archwire/ligating device frictional engagement. Further, this configuration defines a dynamic
5 archwire slot, wherein the archwire is allowed to maintain a "memory" of its slot entry angle, as is now desirable. The notches each comprise a portion that extends labially outwardly from the gingival/occlusal periphery towards the archwire slot and presents concave, curvilinear surfaces to
10 reduce ligature binding. The gingival/occlusal edges of the center legs and wing tip portions of the opposing T-shaped tie wings define an elliptical configuration when viewed labially so as to reduce bracket size and advance patient comfort/appearance. All prominent edges exposed to
15 soft tissue are preferably rounded for patient comfort.

An integral T-shaped hook of the above-described nature may be optionally provided as a cantilevered gingival/occlusal extension of the center leg of either T-shaped tie wing. The T-shaped hook preferably comprises a
20 malleable material and preferably comprises flat lingually and labially facing surfaces, wherein the hook can be manually pivoted to a limited extent by a practitioner relative to the center leg of the tie wing.

An auxiliary slot may also be optionally provided and
25 disposed within the gingival-occlusal center plane of the bracket, underlying the center leg portions of the opposing T-shaped tie wings. Alternatively, twin auxiliary slots may be provided, one on each side of the gingival-occlusal

center plane of the bracket (i.e., mesially and distally positioned), such slots passing under the mesial and the distal convex slot floor portions of the archwire slot. Whether a single or twin auxiliary slot arrangement is provided, each slot preferably has an inner-configuration which will restrict rotation of complimentary auxiliaries inserted thereto, as described above.

The T-shaped tie wings of the bracket may also be optionally defined so that the outer gingival/occlusal facing sidewalls of the tie wing pair define a trapezoid when viewed from the mesial or distal aspects. More particularly, one of the outer sidewalls is disposed at an angle relative to the longitudinal center plane of the archwire slot, and may be perpendicular to the tie wing base surface or base/bottom surface of the bracket. The other outer sidewall is disposed in parallel relation to the center plane of the archwire slot.

In combination with the above-described trapezoidal configuration, the base surface of the bracket, namely its gingival/occlusal extent, may be provided for generating "positive torque," "negative torque," and "no torque." "Positive torque" is applied to a tooth having a tooth-long axis which projects the crown outwardly from a plane which is perpendicular to the occlusal plane and which coincides with the respective arch (e.g., mandibular or maxillary) (e.g., when the tooth root is tipped lingually). "Negative torque" is applied to a tooth having a tooth-long axis which projects the crown inwardly from the above-described

plane (e.g., when the tooth root is tipped buccally). "No torque" is applied to a tooth having a tooth-long axis which is properly within the above-described plane.

The configuration of the base surface of the bracket,
5 namely its occlusal/gingival extent, may be defined in relation to a reference plane which coincides with that portion of the floor or bottom of the archwire slot which engages the archwire when positioned therein (e.g., a plane which is tangent to the two convex portions on the floor of
10 the slot). As an example of the foregoing trapezoidal configuration and base variations, with the "angled" outer sidewall being gingivally positioned in a maxillary application, the base may be configured to generally extend from its gingival edge to its occlusal edge generally
15 toward the noted reference plane to provide for a "positive torque" on the tooth. Moreover, the base may be configured to generally extend from its gingival edge to its occlusal edge generally away from the noted reference plane to provide for "negative torque" on the tooth. Furthermore,
20 the base may be configured to generally extend from its gingival edge to its occlusal edge generally parallel to the noted reference plane to provide for "no torque" on the tooth. With the "angled" outer sidewall being gingivally positioned in a mandibular application, the above-described
25 non-parallel configurations of the base would provide negative and positive torque, respectively.

The center leg of each T-shaped tie wing may also be optionally disposed at an acute angle relative to the

longitudinal center axis of the slot. Such angling may be desired in applications wherein the central axis of the clinical crown is positioned at an acute angle relative to the occlusal plane in normal occlusion. Such angling correspondingly facilitates the practitioner's placement of the bracket on a tooth, wherein the axes of the center legs may be disposed along a tooth long axis, and wherein the center axis of the bracket slot may be disposed parallel to the occlusal plane. Preferably, the mesial/distal facing edges of the center leg of each T-shaped tie wing are also parallel to the axes of the center legs to further facilitate accurate placement on a tooth. It is also preferable for the center axes of opposing ligating support notches to be disposed parallel to the gingival-occlusal center plane of the bracket. Relatedly, for rotational purposes, it is preferable for the apices of the opposing convex slot sidewall portions and a convex slot floor portion correspondingly positioned on the same mesial or distal side to lie within a common plane that is disposed substantially perpendicular to the longitudinal center plane of the archwire slot.

As will be appreciated by those skilled in the art, the embodiment of the invention described herein yields numerous advantageous features, yielding a new state-of-the-art bracket.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1A-C illustrate labial, side and end views of one embodiment of the present invention;

5 Figs. 2A and 2B, and Figs. 2C and 2D, illustrate labial and end views of the embodiment of Figs. 1A-C when ligating support means are employed to support an elastomeric ligature and when ligating support means are not employed to support an elastomeric ligature, respectively;

10 Figs. 3A-C illustrate labial, side and end views of a modified version of said embodiment of the present invention having an integral T-shaped hook and twin auxiliary slots;

15 Figs. 4A-E illustrate labial, side and end views of a modified version of said embodiment of the present invention having outer tie wing sidewalls that define a trapezoid therebetween, the end views illustrating various alternative configurations of the base to provide for positive, negative, and no torque on a tooth;

20 *cd* Figs. 5A-^C~~D~~₁ illustrate labial, side and end views of the modified embodiment of the present invention illustrated in Figs. 4A-C, with a central auxiliary slot;

25 Figs. 6A-C illustrate labial, side and opposing end views of the modified embodiment of the present invention illustrated in Figs. 4A-C, with an angulated gingival-occlusal center axis and twin auxiliary slots; and,

Figs. 7A-B illustrate two views of an exemplary auxiliary device useable with the auxiliary slots of the present invention.

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DETAILED DESCRIPTION

One embodiment of the edgewise bracket 10 of the present invention is illustrated in Figs. 1A-C and 2A-D, with various modifications, modalities and an exemplary auxiliary reflected by Figs. 3A-C, 4A-E, 5A-D, 6A-C and 7A-B. Corresponding features are referenced by common reference numerals.

The edgewise bracket 10 comprises two integral, opposing T-shaped tie wings 12 and 14 having a common base portion and base surface 16, and defining an archwire slot 18 therebetween. By way of example only, a flange 32 may be adjoined to the bracket 10 for subsequent attachment to a band. Alternatively, the bracket may be adjoined to a bonding pad (not shown).

Two sets of opposing ligating support means 20 and 22, are provided, each set comprising a gingivally disposed notch and occlusally disposed notch on the gingival and occlusal edges of tie wings 12,14, respectively. Each ligating support means has a sloped portion 24 and top land portion 26. The sloped portions 24 have concave, curvilinear surfaces.

Each of the T-shaped tie wings 12,14 comprises a cantilevered central leg portion 28 centered upon the gingival-occlusal center axis (lying within plane AA) of

the bracket 10 and cantilevered mesial/distal wing tip portions 30, with the above-noted top land portions 26 integral-therebetween. The gingival/occlusal extremes of the center leg 28 and mesial/distal wing tip portions 30 of the tie wings 12,14 define, from the labial aspect, an elliptical configuration E. In this regard, cantilevered wing tip portions 30 extend a sufficient distance d outward from the outer sidewalls 34, 36 of the tie wings 12, 14, respectively, to retain a ligating device in an arcuate seat 38 formed under the cantilevered tie wing tip portions 30 and center legs 28. Relatedly, the cantilevered center leg 28 of each T-shaped tie wing 12, 14, extends a distance f beyond the outer gingival/occlusal extreme of the ligating support means 20 adjacent thereto, such distance f being at least approximately as great as the distance d.

The sidewalls defining the archwire slot 18 comprise two sets of opposing convex portions 42 to reduce frictional engagement with an archwire. Similarly, the floor of archwire slot 18 is provided with two convex portions 44 extending transversely across the archwire slot 18 to reduce frictional engagement with an archwire. As illustrated in Figs. 1A-C, the ligating support means 20, convex slot sidewall portions 42, and convex slot floor portion 44 disposed on the same side of the gingival-occlusal center plane AA may have a common center axis (lying within plane BB). As such, frictional engagement between an archwire and the slot walls and base, and between an archwire and ligating device supported on

ligating support means 20 occurs in a limited region about plane BB.

An optional auxiliary slot 70 may be provided to receive a complimentary auxiliary device, such as the exemplary auxiliary 74 illustrated in Figs. 7A and 7B. The inner sidewalls of auxiliary slot 70 and interfacing shaft portion 76 of the exemplary auxiliary 74 are preferably configured to restrict rotational movement therebetween. As illustrated, a complimentary square-angled configuration may be employed. Additionally, the auxiliary 74 preferably comprises an extending portion 78 having an outer configuration which will not fit into auxiliary slot 70, thereby facilitating placement and removal.

Figs. 2A-B illustrate the interface between an archwire X and elastomeric ligating device Y when both sets of the ligating support means 20 of the embodiment of the present invention illustrated in Figs. 1A-C are utilized. Figs. 2C-D illustrate the interface between an archwire X and elastomeric ligating device Y when neither of the ligating support means 20 of such embodiment are utilized. As will be appreciated by those in the art, there are different treatment situations where each of these modalities may be desired. Additionally, the provision of a set of ligating support means 20 on each of the mesial and distal sides of the bracket 10 allows a practitioner to utilize one set but not the other, as may be desirable.

In Figs. 3A-C an integral T-shaped hook 50 is provided as an extension to the center leg 28 of one of the T-shaped

tie wings 12. The T-shaped hook 50 preferably comprises flat lingual and labial surfaces (see Fig. 3C), and is preferably malleable to allow for pivotal movement relative to center leg 20. The T-shaped hook 50 preferably
5 comprises a tapered portion 52, arcuate neck portion 54 and head portion 56, whereby retention of a traction device in neck portion 54 is enhanced.

Twin auxiliary slots 80 may be optionally provided for receipt of an auxiliary device, such as the exemplary
10 auxiliary 74 shown in Figs. 7A-B. The twin auxiliary slots 80 are beneficially disposed under the convex slot floor portions 44. The configuration of slots 80 and exemplary auxiliary 74 may be as described above to restrict rotational movement therebetween and facilitate placement/
15 removal.

Figs. 3A-C also illustrate optional saddles 60 which can be provided in the support landing portions 26 for receiving a ligating device. It is believed that such saddles 60 may be beneficial in certain early treatment
20 situations for purposes of retaining an undersized archwire in the desired position for rotational purposes.

In Figs. 4A-E, the outer sidewall 34 of tie wing 12 and outer sidewall 36 of tie wing 14 define a trapezoid therebetween. Specifically outer side wall 34 is angled
25 relative to the longitudinal center plane CC of the archwire slot 18, and the outer tie wing sidewall 36 is disposed in parallel relation to the center plane CC of the archwire slot 18. By virtue of this arrangement, the outer

sidewall 34 may be, for example, advantageously disposed gingivally on partially erupted upper bicuspids. Further, bracket systems employed by this configuration will generally reduce bracket/tooth contact between upper and
5 lower arches.

Referring in more detail to Figs. 4C-E, the trapezoidal configuration of the bracket 10 is illustrated with three alternate configurations for the base portion 16. Generally, the configuration of the base portion 16,
10 namely its occlusal/gingival extent, may be defined in relation to the reference plane RP. As can be seen in Figs. 4B-E, the reference plane RP coincides with that portion of the bottom or floor of the archwire slot 18 which engages the archwire when positioned therein (e.g.,
15 a plane which is tangent to the two convex slot floor portions 44.

The configurations of base portion 16 in Figs. 4C-E allow a practitioner to provide positive, negative, and no torque on a tooth of a particular orientation. Initially,
20 with the tie wing 34 being gingivally positioned in a maxillary application, the base portion 16 of Fig. 4C would be used to provide for "positive torque" on a tooth, the base portion 16 of Fig. 4D would be used to provide for "negative torque" on a tooth, and the base portion 16 of
25 Fig. 4E would be used to provide for "no torque" on a tooth. More particularly, in the case of the bracket 10 of Fig. 4C the base portion 16 would thereby extend from its gingival edge to its occlusal edge generally toward the

reference plane RP in order to properly orient the archwire slot 18 on the orthodontic patient. Moreover, in the case of the bracket 10 of Fig. 4D the base portion 16 would thereby extend from its gingival edge to its occlusal edge generally away from the reference plane RP in order to properly orient the archwire slot 18 on the orthodontic patient. Furthermore, in the case of the bracket 10 of Fig. 4E the base portion 16 would thereby extend from its gingival edge to its occlusal edge generally parallel with the reference plane RP in order to properly orient the archwire slot 18 on the orthodontic patient.

In the event that the tie wing 36 is gingivally positioned in a mandibular application, the base portion 16 of Fig. 4C would provide for "negative torque" on the tooth, the base portion 16 of Fig. 4D would provide for "positive torque" on the tooth, and the base portion 16 of Fig. 4E would provide "no torque" on the tooth.

The modified embodiment illustrated in Figs. 4A-C is shown with additional features in Figs. 5A-C and 6A-C, although the bracket 10 of Figs. 4D-E could be similarly modified as well. In Figs. 5A-C, a central auxiliary slot 70 is provided. Figs 6A-C illustrate the inclusion of twin auxiliary slots 80 for receiving of auxiliary devices. The twin vertical slots 80 are disposed so that each passes under one of the convex slot floor portions 44.

In the version shown in Figs. 6A-C, it should also be appreciated that the gingival-occlusal center axis of the bracket (lying within plane AA) can be disposed at an acute

angle relative to center axis of archwire slot 18 (lying within plane CC). More particularly, center legs 28 may be centered upon the gingival-occlusal center axis and may be provided with distal/mesial surfaces 84 which are parallel to the gingival-occlusal center axis thereby facilitating placement of the bracket. In this modified version, it should be recognized that while the center plane BB of the ligating support means 20 is also disposed parallel to the gingival-occlusal center axis, the apices of the convex slot sidewall portions 42 and convex slot floor portion on each of mesial and distal sides lie in a plane which is perpendicular to the archwire slot center plane CC. Relatedly, it should be appreciated that, when a T-shaped hook is utilized (such as the T-shaped hook 50 illustrated in Figs. 3A-C above), the center axis thereof will be disposed perpendicularly to the center axis of the archwire slot 18 and at an angle relative to the gingival-occlusal center axis of the bracket 10.

The foregoing description of the present invention has been provided for purposes of illustration and description. This description is not intended to limit the invention and various modalities thereof. Variations, embodiments and modifications will be apparent to those skilled in the art and are intended to be within the scope of the following claims.